Accelerator Division
Alternating Gradient Synchrotron Department
BROOKHAVEN NATIONAL LABORATORY
Upton, New York 11973

Accelerator Division
Technical Note

AGS/AD/Tech. Note No. 369

TEVATRON STUDIES REPORT

G. Jackson, D. McConnell, and B. Fellenz
Fermi National Accelerator Laboratory

E. Raka and S.P. Yamin
Brookhaven National Laboratory

December 3, 1992

Introduction

On Wednesday, July 24, 1991, we studied the effectiveness of "constant amplitude" transverse damping at the Fermilab Tevatron. In this mode of damping, whenever a bunch's displacement exceeds a specified threshold, a constant (usually maximum) amplitude correction pulse is applied to the damper kicker. This is in contrast to the "linear" mode, where the kick is proportional to the displacement.

Procedure

The beam was injected into the Tevatron with vertical displacement, so as to induce vertical betatron oscillations. Figure 1 shows the output of one of the pick-up electrodes (PUEs) for 1024 successive turns. The modulation is caused by the changing coherence of the oscillations of particles of different momenta (and tune because of the chromaticity) around the synchrotron oscillation cycle. Decoherence is responsible for the damping of the oscillations. If we assume that, then the amplitude is given by $A = A_0 \exp[-(\text{turn }\#)/k]$, $k = 2661$ turns.

We next studied the properties of various damping transfer functions. These are shown in Figures 2a-2d. In all cases the abscissa represents displacement from the "closed orbit" in millimeters and the ordinate the voltage applied to the kicker electrodes ($\pm$ 1000 V maximum).

First we studied linear damping (Figure 2a). The results are shown in Figure 3. Here, we get $k = 1089$ turns.

For the mixed constant-amplitude and linear transfer function shown in Figure 2b, we got the results shown in Figure 4. The fit to the damping constant gives k = 739 turns.

A constant amplitude transfer function with the threshold set at $\pm$ 2.5 mm is shown in Figure 2c and the results are plotted in Figure 5. k = 1002 turns.

Constant-amplitude damping with a $\pm$ 1 mm transfer function threshold is shown in Figure 2d. These results are given in Figure 6. k = 797 turns.

Conclusions

We believe that we have shown that constant-amplitude damping can be as effective as linear damping in the Tevatron. However, since this machine operates in a regime in which resistive wall instabilities are not present and where the Landau damping is sufficient, the present studies do not represent an adequate test. We suggest extending these tests to the Main Ring, where there is a resistive wall instability. Unfortunately, this will require modifying more than software.

mvh
yamin.tec

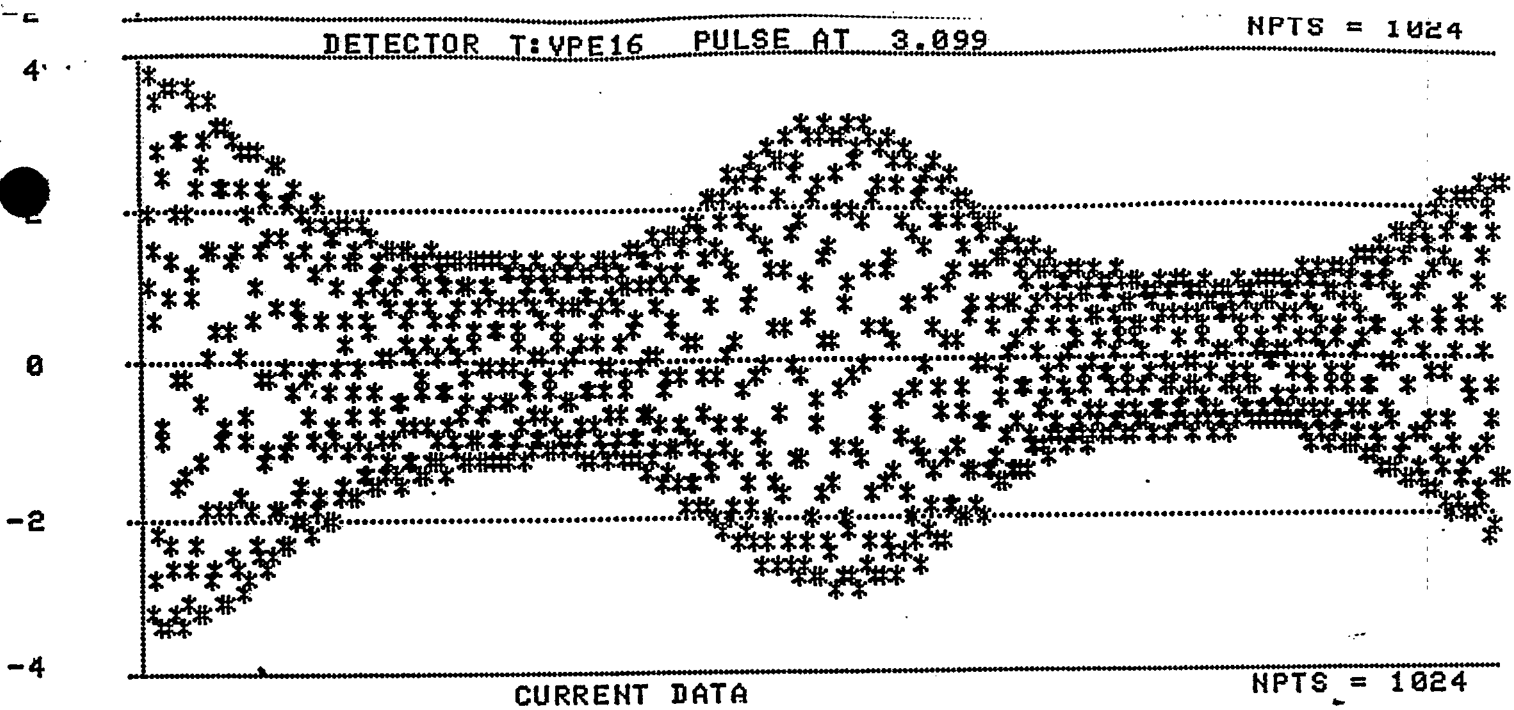

FIGURE 1 — NO DAMPING

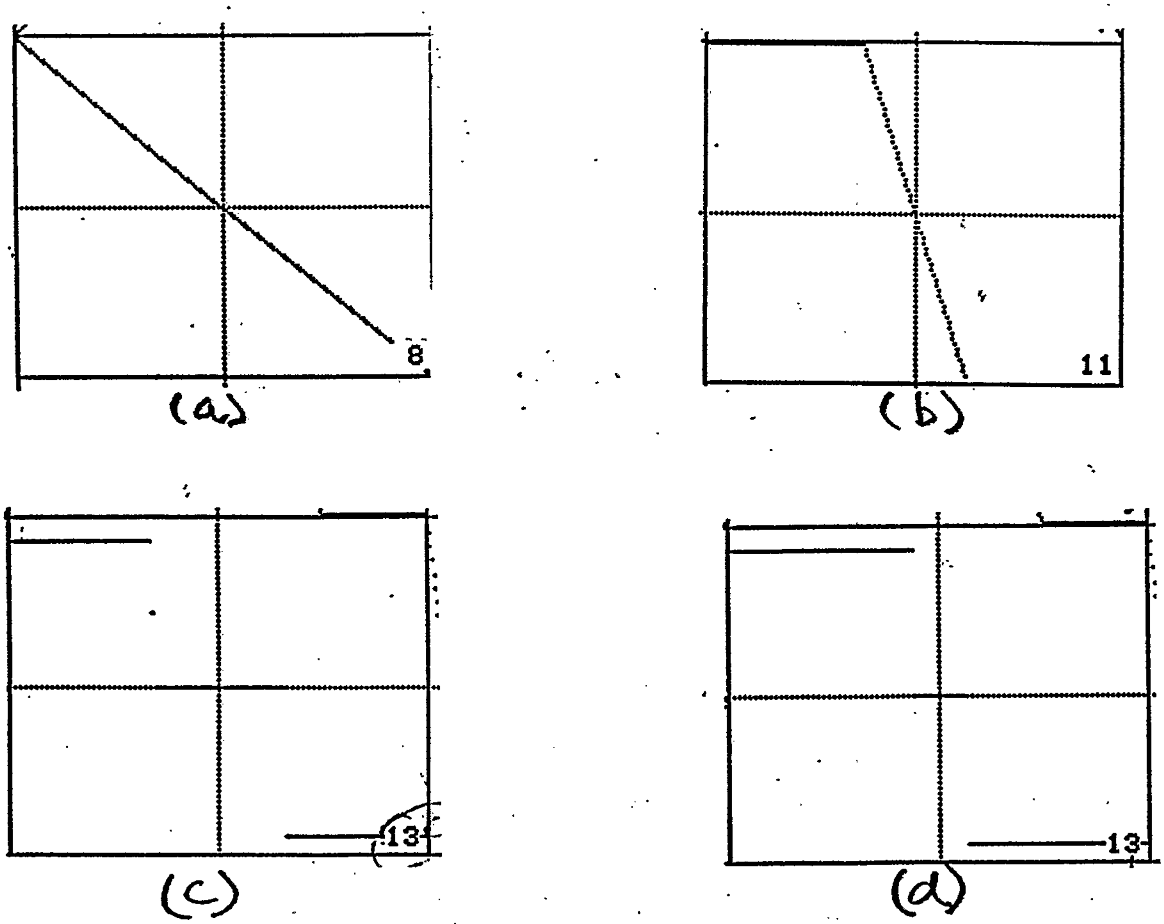

FIGURE 2 — TRANSFER FUNCTIONS

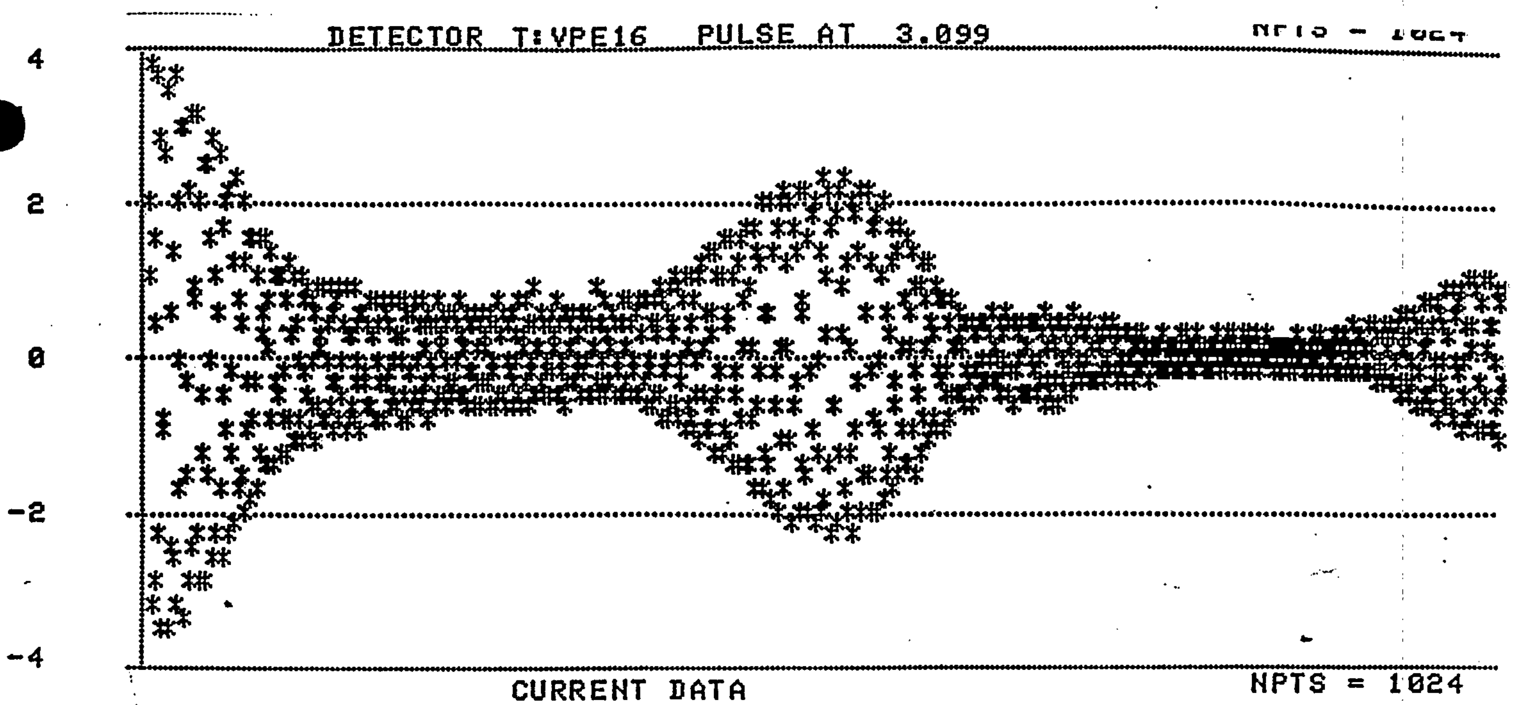

FIGURE 3 - LINEAR DAMPING

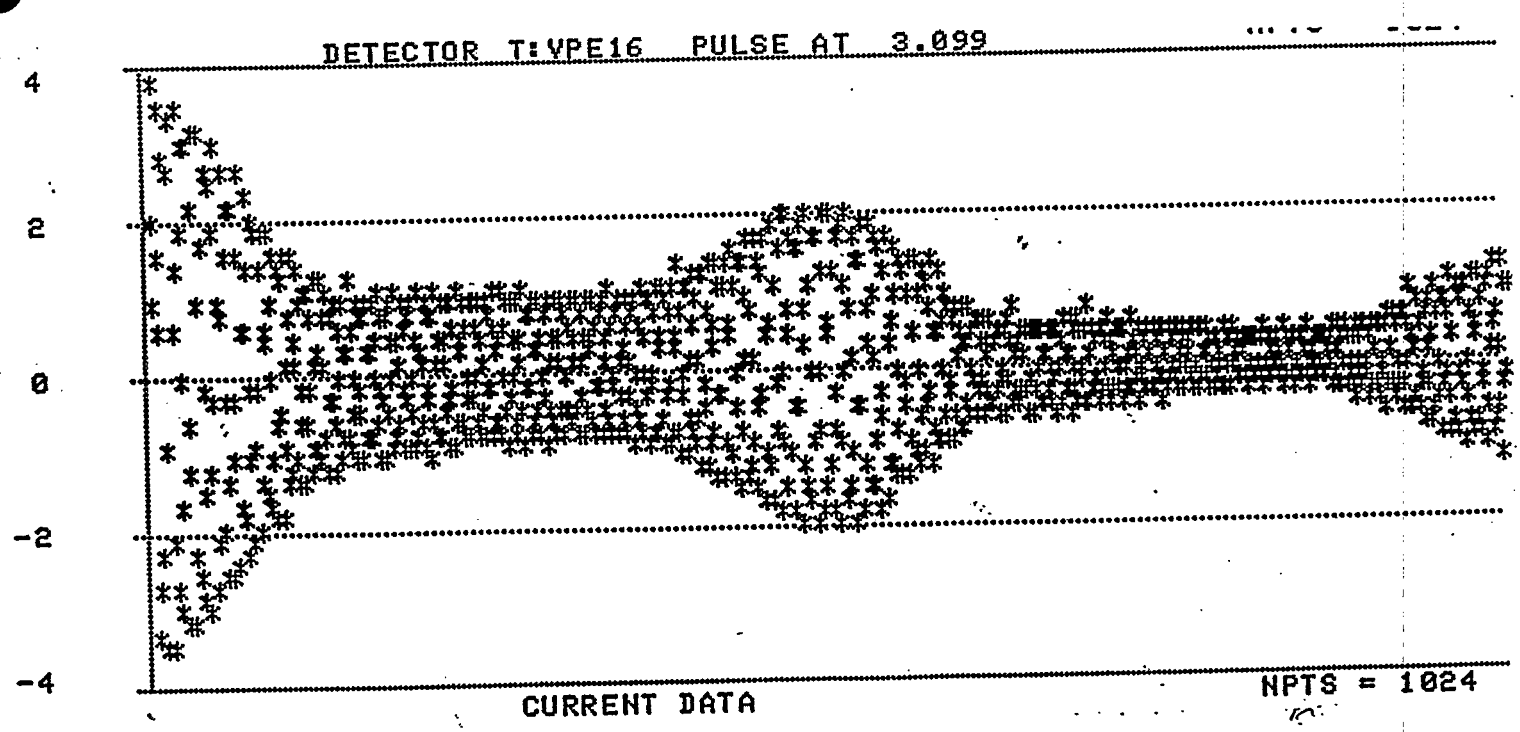

FIGURE 4 - MIXED LINEAR/CONSTANT DAMPING

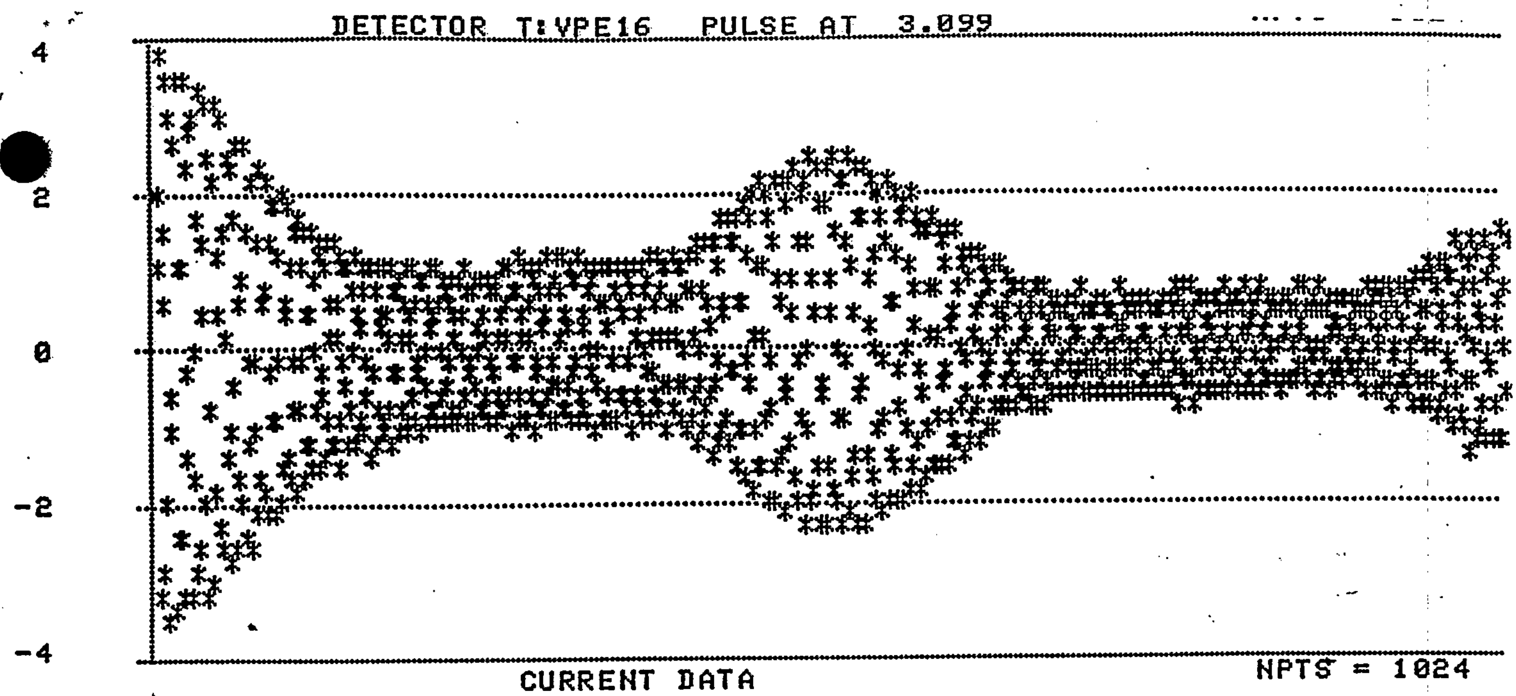

FIGURE 5 – CONSTANT AMPLITUDE (±2.5mm) DAMPING

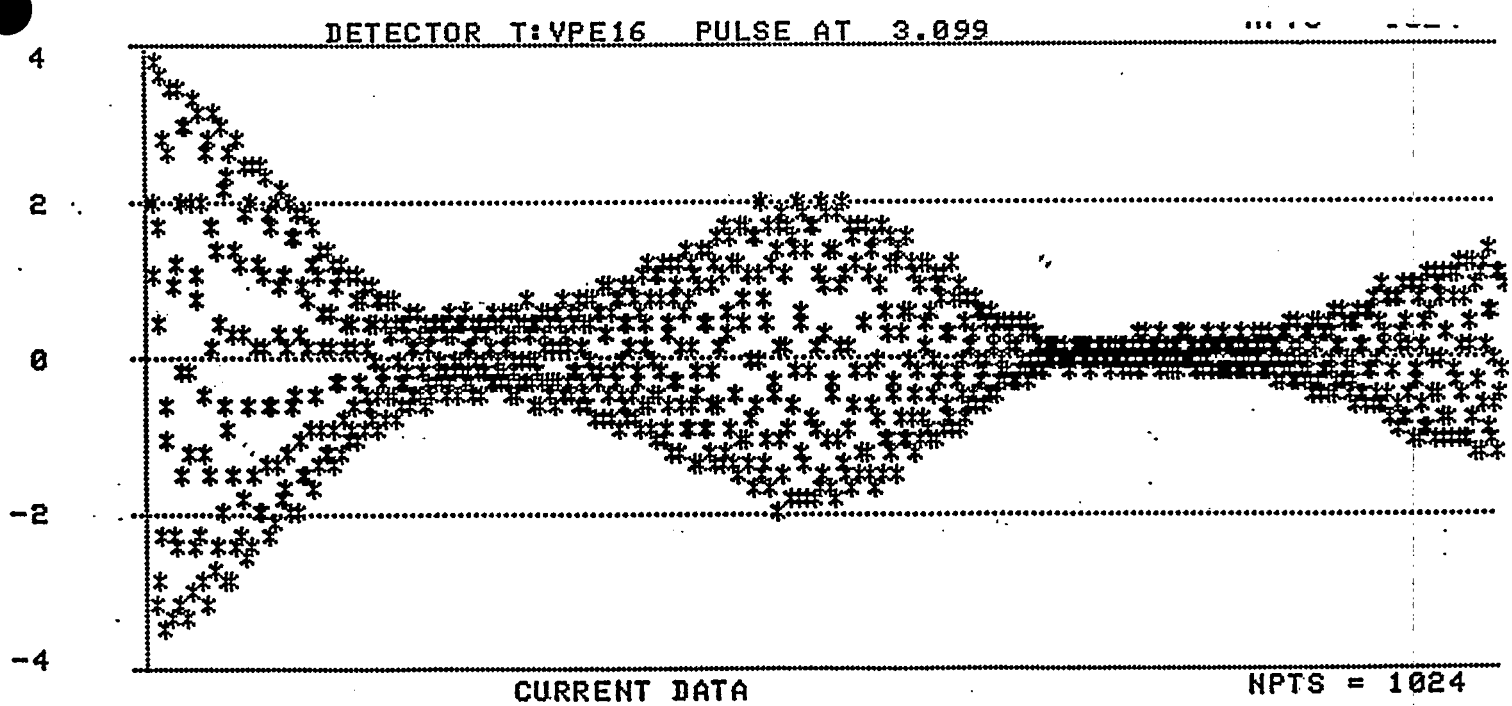

FIGURE 6 – CONSTAND AMPLITUDE (±1mm) DAMPING